OLYMPUS®

Ⅰ. SAFETY GUIDE
Ⅱ. SYSTEM OUTLINE & SPEC.
Ⅲ. PACKING DETAILS CHECK
Ⅳ. OPERATION INSTRUCTIONS
Ⅴ. TROUBLESHOOTING
Ⅵ. BACKPANEL SWITCH SETTINGS

CONFOCAL LASER SCANNING BIOLOGICAL MICROSCOPE

User's Manual

FV5-LD405/440
FV5-LDPSU

Semiconductor Laser Head / Laser Power Supply Unit

Petition

Thank you for purchasing the system at this time. Please read this instruction manual carefully before using this system in order to get optimum performance of this system and also for safety considerations. This manual contains six sections – [SAFETY GUIDE], [SYSTEM OUTLINE & SPEC.], [PACKING DETAILS CHECK], [OPERATING INSTRUCTIONS], [TROUBLESHOTTING] and [BACKPANEL SWTCH SETTINGS]. When using this system, put this manual under your control and keep it carefully even if you read over.

AX7332

Caution

1. This manual – part or whole, shall not be used or reproduced without permission.
2. Information in this manual is subject to change without notice.

Manual configuration for this system

This manual comprises with six sections and describes the following articles respectively.

Ⅰ. SAFETY GUIDE

This section describes requests, cautions and kinds of warning labels when using this system.

1 Safety considerations ..... Ⅰ. 1-1
2 Warning label ..... Ⅰ. 2-1
3 Cautions when using the system ..... Ⅰ. 3-1
4 USER'S SAFETY PROTECTION MEASURES ACCORDING TO IEC60825-1:1993+A1:1997+A2:2001 "LASER PRODUCT RADIATION SAFETY STANDARD" ..... Ⅰ. 4-1

Ⅱ. SYSTEM OUTLINE & SPEC.

This section describes outline of the system and specifications.

1 System outline ..... Ⅱ. 1-1
2 Specifications ..... Ⅱ. 2-1
3 Operating hours ..... Ⅱ. 3-1

Ⅲ. PACKING DETAILS CHECK

This section describes details of packing for this system.

1 Integration with this system ..... Ⅲ. 1-1
2 Packing details ..... Ⅲ. 2-1
3 Setup ..... Ⅲ. 3-1

Ⅳ. OPERATION INSTRUCTIONS

This section describes operating method of this system.

1 Powering up and shutdown ..... Ⅳ. 1-1
2 Laser emission ..... Ⅳ. 2-1
3 Laser intensity change ..... Ⅳ. 3-1

4 Description of LED indicators ..... IV. 4-1

V. TROUBLESHOOTING

This section describes countermeasures to the troubles.

1 Countermeasure when trouble occurs ..... V. 1-1

VI. BACK PANEL SWITCH SETTINGS

This section describes back panel switch settings.

1 Warning to back panel switch settings ..... VI. 1-1

Book Conventions of this manual

This manual describes each section, using the following book conventions.

✧ Symbols for warning, caution and hint used

Conventions	Description
	Indicates a warning to user to prevent injuries and or damage of products (including peripheral furniture's)
	Indicates details of caution to prevent damage or deterioration of products.
	Indicates a tip or hint.

I. SAFETY GUIDE

Note for this section

This section describes cautions in order to use this system safely. Please read this section for sure before using the system.

System may not be guaranteed when it is used with other methods than described in this manual. Unless instructions are observed, more trouble may occur. Please use this system in accordance with this manual.

1 Safety Considerations 1-1

2 Warning label 2-1

2-1 Label related to laser safety 2-1

2-1-1 Warning label..... 2-1

2-1-2 Aperture label 2-2

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3 Cautions when using the system 3-1

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4 USER'S SAFETY PROTECTION MEASURES ACCORDING TO IEC60825-1:1993+A1:1997+A2:2001 "LASER PRODUCT RADIATION SAFETY STANDARD" 4-1

Regarding DIP switches at back panel of FV5-LDPSU, see Ⅵ – 1 [Warning to back panel switch settings].

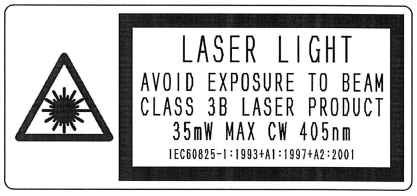
1 Safety Considerations ⚠

This system designates the use of laser products of the following class.

In case of FV5-LD405

CLASS Ⅲb(CDRH)

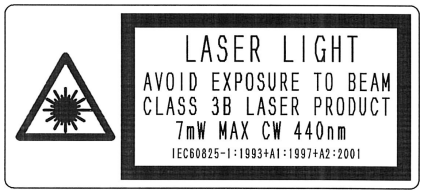
CLASS 3B (IEC60825-1:1993+A1:1997+A2:2001
EN60825-1: 1994+A11:1996+A2:2001
JIS C6802: 997+A1:1998)



In case of FV5-LD440

CLASS Ⅲb(CDRH)

CLASS 3B (IEC60825-1:1993+A1:1997+A2:2001
EN60825-1: 1994+A11:1996+A2:2001
JIS C6802: 1997+A1:1998)

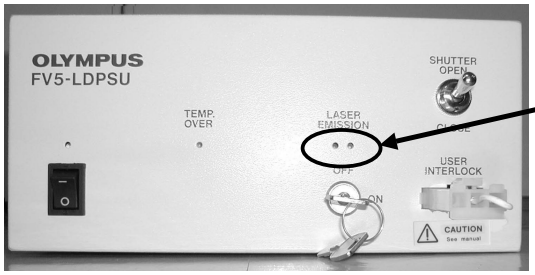


Laser products of class 3B can only be used under control of laser safety officer. Before using laser products, refer to Chapter 4 – "USER'S SAFETY PROTECTION MEASURES ACCORDING TO IEC60825-1:1993+A1:1997+A2:2001 "LASER PRODUCT RADIATION SAFETY STANDARD", and exercise adequate countermeasures and then, use the laser products. Should you have any open question, contact our local sales office.

Caution when using

Pay your utmost attention to the following points.

⚠ **When red LED's of LASER EMISSION on FV5-LDPSU are lighting, it indicates that laser is being emitted. When microscope is connected, the laser is emitted from objective tip. Reflection may enter your eyes or light may be scattered around. Care must be taken in this case. In addition, do not see the sample while laser is scanning.**



When two red LED's are lighting, it means "laser emission".

Regarding settings of DIP switches located at back panel of FV5-LDPSU, refer to Ⅵ 1 – Back panel switch settings.

- Set this system on robust base.

- This system generates heat. When installing this system, make it sure that a space of 10cm or more is provided, left and right of the system, and do not block vent openings.

- Power cable may be molten when it hits hot place of lamp housing. When installing, make it sure that the power cable is adequately apart from the lamp housing.

- Never insert a metal piece into vent opening as it may cause failure or electric shock.

- Do not apply your hand or finger to laser beam that comes from mounting hole of objective lens or objective tip.
  If your hand or finger is exposed to laser beam, it may cause a skin hazard. In addition, never insert a mirror into light path as the laser beam may come outside and it may enter your eye which is very dangerous

- Do not set or remove the sample during laser emission (laser scanning). If you set or remove the sample in such a case, reflection from the sample may enter your eye which is very dangerous. Moreover, do not look at the sample during laser emission (laser scanning).

- System performance as well as system safety cannot be guaranteed in case that cover is detached or the system is disassembled with use of tools. Never disassemble the system.

- Do not bend or pull fiber excessively. Do not step on the fiber. If the fiber is broken, laser beam may leak which is very dangerous. In case that such unlikely event occurred, turn power of laser power supply unit to OFF position immediately and contact our sales office. (when using FV5-LD405 only)

- Always use the power cord provided by Olympus. If no power cord is provided, please select the proper power cord by referring to the section “PROPER SELECTION OF THE POWER SUPPLY CORD ”at the end of this instruction manual.

- Connect the power cord correctly and ensure that the ground terminal of the power supply and that of the wall outlet are properly connected. If the equipment is not grounded, Olympus can no longer warrant the electrical safety and performance of the equipment.

- Before connecting cord and cable, verify that the main switch is turned to O – (OFF) position.

- Mixture (alcohol (3): ether (7)) that is used for cleaning optics is high inflammable so that utmost care must be taken when handling with respect to fire and main switch ON/OFF. When using ether, it is recommended that the room is well-ventilated.

- Be careful so as not to apply any excessive force to connecting cord or cable as it is very weak against bend or twist.

- Do not change fuses that are located above the power cord connector. When change of fuses is required, contact and consult with our local sales office.

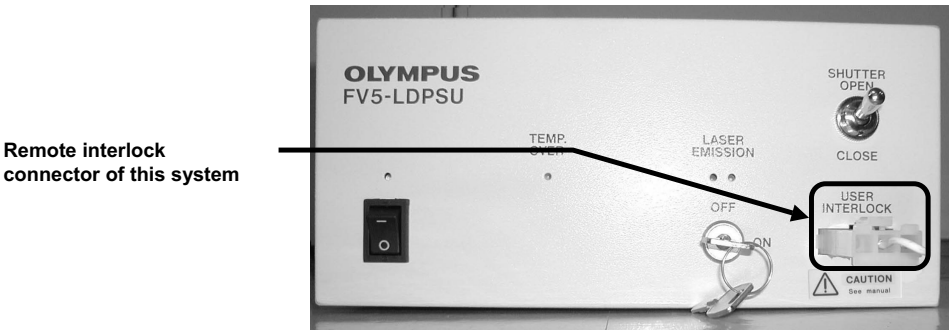
- Do not carry the semiconductor laser head by hand. It may be damaged as it is very delicate tool.

- Do not swing around fiber carelessly. If fiber being emitted is swung around, laser beam may hit human body that would cause a hazard. (when using FV5-LD405 ONLY)

- When you dispose of this system, it is necessary to handle it as an industrial waste. In case that you cannot dispose it yourself, deliver it to our local sales office.

- External remote control connector is provided.
  (Rating of external remote interlock circuit: Rated current 0.3A, Rated voltage 5V)
  When shipping, a short pin of interlock connector is provided. Instead of the short pin, the external remote interlock circuit can be connected. For further details, see Chapter 4 - USER'S SAFETY PROTECTION MEASURES ACCORDING TO IEC60825-1:1993+A1:1997+A2:2001 "LASER PRODUCT RADIATION SAFETY STANDARD".

When using remote interlock connector, contact our local sales office for sure as it may cause electric shock or fire.



- See also instruction manual for microscope regarding safety considerations.

Symbols related to safety

This system is attached with the following marks.
Understand the meaning of symbols and handle the system safely.

Symbol	Meaning
	Before using, read instruction manual for sure. In case of error handling, user may get hazard or products may be damaged.
	Laser beam is used. Pay utmost care to handling.
	Main switch is turned ON.
	Main switch is turned OFF.

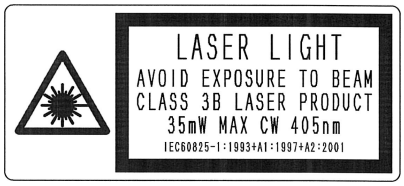
2 Warning label

2-1 Label related to laser safety

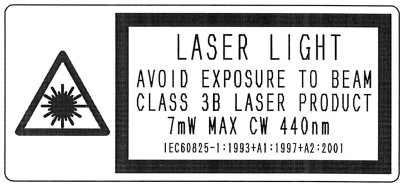
Warning is displayed at the place where a care must be paid in handling and operating the system. Exercise the instruction for sure. When label is blurred or peeled off, contact our local sales office and ask if new label for change is available.

2-1-1 Warning label

The warning label shown below is attached to the system.

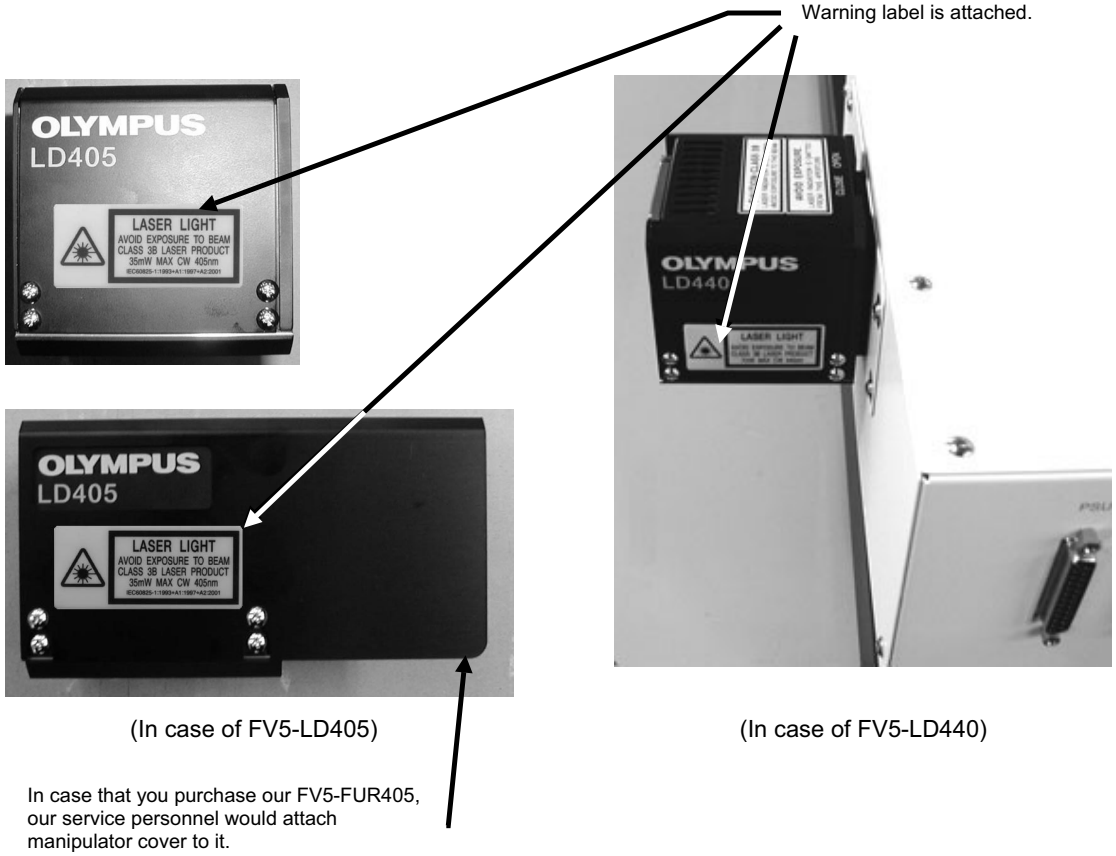


(In case of FV5-LD405)



(In case of FV5-LD440)

Place attached



(In case of FV5-LD405)

(In case of FV5-LD440)

Warning label / Label related to laser safety

2-1-2 Aperture label

Aperture label shown below is attached to the system.

Place attached

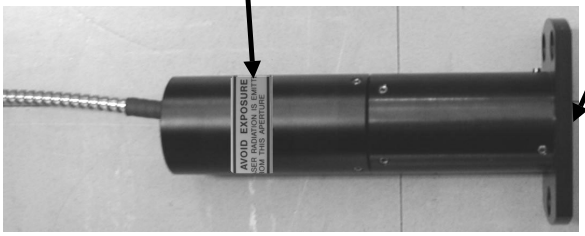
Aperture label is attached.

(In case of FV5-LD405)

In case that you purchase our FV5-FUR405, our service personnel would attach manipulator cover to it.

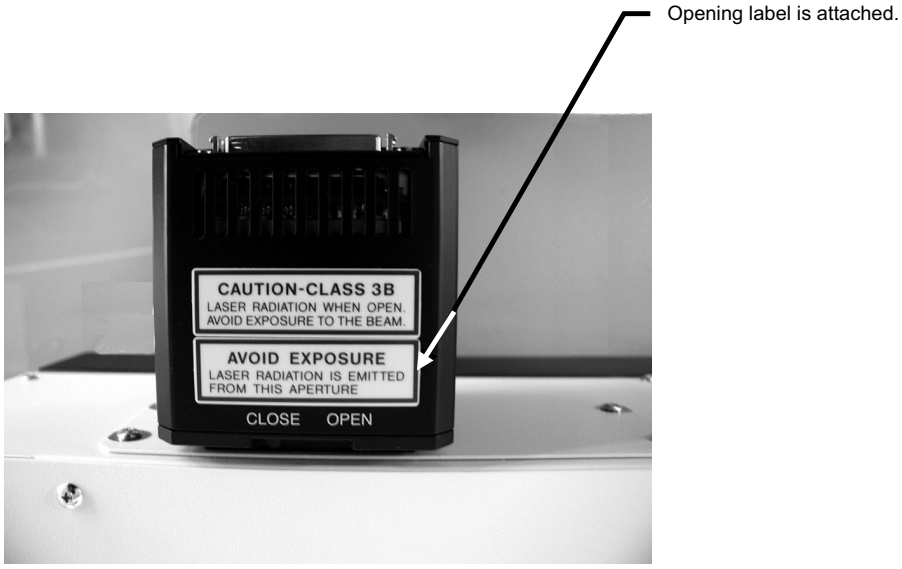
The case where the shutter is open and the fiber cable disconnected.

Aperture label is attached.



Laser beam comes out here.

(In case of FV5-LD405)

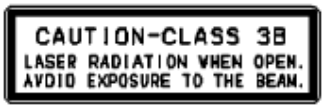


(In case of FV5-LD440)

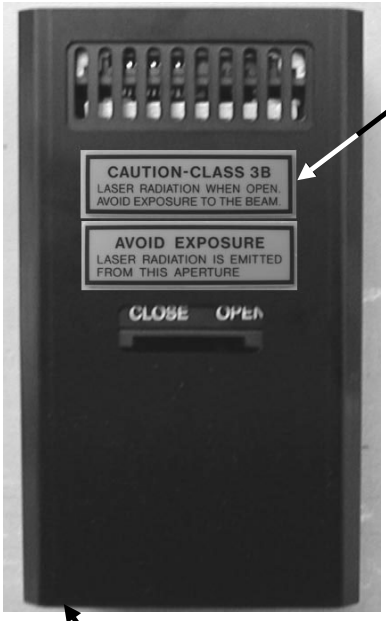
Warning label / Label related to laser safety

2-1-3 Protective housing label

Protective housing label as shown below is attached to the system.



Place attached



Protective housing label is attached.

(In case of FV5-LD405)

In case that you purchase our FV5-FUR405, our service personnel would attach manipulator cover to it.

The case where the shutter is open and the fiber cable disconnected.

(In case of FV5-LD440)

Protective housing label may be attached to the place other than the place shown in this manual. It is a warning label for our service personnel.

When label is blurred or peeled off, contact our local sales office for availability of label for change.

3 Cautions when using the system

3-1 About system move

- Assembling and setup of this system are executed by our service parsonnel. Avoid move of the system as it may put optics system out of order. When the move of this system is required, contact and consult with our local sales office. In an event of disorder or breakage of the system due to the move by customer, we hold no responsibility.

3-2 Caution when using

- Handle this system with utmost care in order not to give a shock as it is precision instrument.
- Do not bend, pull or step on fiber excessively. Performance would severely be deteriorated. (when using FV5-LD405 only).
- Power cable is also used to stop power supply against unlikely event. Power cable connector (located at back panel of FV5-LDPSU) or power consent should be within a reach of your hand. Set the power supply unit at the place where you can remove power cable easily against unlikely event. However, do not remove it during power supply except emergency situation.
- Do not move the system by pulling power cable.
- For environment condition of usage, see II Chapter 2 – Specifications.
- When you clean each section, use soft cloth that contains diluted mild detergent and wipe out gently. Do not use organic solvent as it would deteriorate paint or plastic parts.

3-3 Caution

Safety may not be guaranteed if the system is used by other methods than those described in this manual and failure may occur. Use this system in accordance with this manual.

4 USER'S SAFETY PROTECTION MEASURES ACCORDING TO IEC60825-1:1993+A1:1997+A2:2001 "LASER PRODUCT RADIATION SAFETY STANDARD"

IEC60825-1:1993+A1:1997+A2:2001 requires the users of laser products to take proper safety protection measures (summarized below). When using this system, be sure to take proper measures regarding the following points.
For details, please refer to the IEC60825-1:1993+A1:1997+A2:2001 mentioned above.
For warning labels used with this system and their positions, see Section 2, "Warning Labels" of this manual.

This requirement does not apply to Class 3B laser products with not more than five times the AEL of Class 2 in the wavelength range from 400 nm to 700 nm.

NOTE 1 There is only limited evidence about effects for exposures of less than 10^{-9}s for wavelengths less than 400 nm and greater than 1400 nm. The AELs for these exposure times and wavelengths have been derived by calculating the equivalent radiant power or irradiance from the radiant power or radiant exposure applying at 10^{-9}s for wavelengths less than 400 nm and greater than 1400 nm.

NOTE 2 Correction factors C_1 to C_7 and breakpoints T_1 and T_2 used in tables 1 to 4 are defined in the following expressions and are illustrated in figures 1 to 8.

Parameter	Spectral region	Figures
$C_1 = 5{,}6 \times 10^{3} t^{0,25}$	302,5 to 400	1
$T_1 = 10^{0,8(\lambda-295)} \times 10^{-15}$s	302,5 to 315	2
$C_2 = 10^{0,2(\lambda-265)}$	302,5 to 315	3
$T_2 = 10 \times 10^{[(\alpha-\alpha min)/98,5]}$s[a]	400 to 1400	4
$C_3 = 1{,}0$	400 to 450	5
$C_3 = 10^{0,02(\lambda-450)}$	450 to 600	5
$C_4 = 10^{0,002(\lambda-700)}$	700 to 1050	6
$C_4 = 5$	1050 to 1400	6
$C_5 = 10^{-1/4}$ [b]	400 to 10^{6}	7
$C_6 = 1$ for $\alpha \leq \alpha_{min}$	400 to 1400	[c]
$C_6 = \alpha/\alpha_{min}$ for $\alpha_{min} < \alpha \leq \alpha_{max}$	400 to 1400	[c]
$C_6 = \alpha_{max}/\alpha_{min} = 66{,}7$ for $\alpha > \alpha_{min}$[d]	400 to 1400	[c]
$C_7 = 1$	700 to 1150	8
$C_7 = 10^{0,018(\lambda-1150)}$	1150 to 1200	8
$C_7 = 8$	1200 to 1400	8

[a] $T_2 = 10$ s for $\alpha < 1{,}5$ mrad and $T_2 = 100$ s for $\alpha > 100$ mrad

[b] C_5 is only applicable o pulse durations shorter than 0,25 s.

[c] C_6 is only applicable to pulsed lasers and to CW lasers where thermal injury dominates (see table 1)

[d] The limiting angle of acceptance γ_p shall be equal to α_{max}

$\alpha_{min} = 1{,}5$ mrad

$\alpha_{max} = 100$ mrad

N is the number of pulses contained within the applicable duration (see 8.4f) and 13.3)

NOTE 3 See table 7 for limiting apertures.

NOTE 4 In the formulae in the tables 1 to 4 and in these notes, the wavelength has to be expressed in nanometres, the emission duration t has to be expressed in seconds and α has to be expressed in milliradians.

10 *Safety precautions*

10.1 *General*

This section specifies safety precautions and control measures to be taken by the user of a laser product, in accordance with its hazard classification. Often users can use the manufacturer's classification of the product for classification of the laser installation, thus avoiding all measurements. This section is supplied for the user's information. Nothing in this section shall be considered as constraints or requirements imposed upon the manufacturer. For installations where Class 3R laser products emitting energy outside of the 400nm to 700nm wavelength range or Class 3B or Class 4 laser products are operated, a laser safety officer should be appointed. It should be the laser safety officer's responsibility to review the following precautions and designate the appropriate controls to be implemented. If should be the laser safety officer's responsibility to review the following precautions and designate the appropriate controls to be implemented. Wherever practicable, laser protective enclosures should be used for lasers of Class 3B or Class 4. Warning labels should be placed upon removable parts of protective enclosures or at service connections where a hazard is introduced by their removal or by disconnection.

The purpose of safety precautions and control measures is to reduce the possibility of exposure to hazardous levels of laser radiation, and to other associated hazards. Therefore, it may not be necessary to implement all of the control measures given. Whenever the application of any one or more control measures reduces the possible exposure to a level at or below the applicable MPE, then the application of additional control measures should not be necessary.

If a user modification of a previously classified laser product affects any aspect of the product's performance or intended functions within the scope of this standard, the person or organization performing any such modification is responsible for ensuring the reclassification and relabelling of the laser product.

10.2 *Use of remote interlock connector*

The remote interlock connector of Class 3B and Class 4 lasers should be connected to an emergency master disconnect interlock or to room, door or fixture interlocks (see 4.4).

The person in charge may be permitted momentary override of the remote interlock connector to allow access to other authorized persons if it is clearly evident that there is no optical radiation hazard at the time and point of entry.

10.3 *Key control*

Class 3B and Class 4 laser products not in use should be protected against unauthorized use by removal of the key from the key control (see 4.5).

10.4 *Beam stop or attenuator*

The inadvertent exposure of bystanders to laser radiation from Class 3B or Class 4 laser products should be prevented by the use of the beam attenuator or beam stop (see 4.7).

10.5 *Warning signs*

The entrances to areas or protective enclosures containing Class 3B and Class 4 laser products should be posted with appropriate warning signs.

10.6 *Beam paths*

The beam emitted by each Class 1M and Class 2M laser product classified under condition 1 of table 10, each Class 3R laser product emitting energy outside of the 400nm to 700nm wavelength range, and each Class 3B or Class 4 laser product should be terminated at the end of its useful path by a diffusely reflecting material of appropriate reflectivity and thermal properties or by absorbers.

Open laser beam paths should be located above or below eye level where practicable.

The beam paths of Class 3R laser products emitting energy outside of the 400nm to 700nm wavelength range and Class 3B or 4 laser products should be as short as practicable, should have a minimum number of directional changes, should avoid crossing walkways and other access routes, and should, where practicable, be enclosed. The beam enclosure (for example, a tube) should be securely mounted but preferably not rigidly attached to (or provide support for) beam-forming components.

10.7 *Specular reflections*

Care should be exercised to prevent the unintentional specular reflection of radiation from Class 3R, Class 3B or Class 4 laser products. Mirrors, lenses and beam splitters should be rigidly mounted and should be subject to only controlled movements while the laser is emitting.

Care should be exercised to prevent the unintentional specular reflection of radiation from Class 1M and Class 2M laser products from surfaces that may focus the beam.

Reflecting surfaces that appear to be diffuse may actually reflect a considerable part of the radiation beam specularly, especially in the infra-red spectral range. This may be potentially hazardous for longer distances than one would expect for purely (Lambertian) diffuse reflections.

Special care needs to be taken in the selection of optical components for Class 3B and Class 4 lasers and in maintaining the cleanliness of their surfaces.

Potentially hazardous specular reflections occur at all surfaces of transmissive optical components such as lenses, prisms, windows and beam splitters.

Potentially hazardous radiation can also be transmitted through some reflective optical components such as mirrors (for example, infra-red radiation passing through a reflector of visible radiation).

10.8 *Eye protection*

Eye protection which is designed to provide adequate protection against specific laser wavelengths should be used in all hazard areas where Class 3R laser products emitting energy outside of the 400 nm to 700 nm wavelength range, Class 3B or Class 4 lasers are in use (see clause 12). Exceptions to this are

a) when engineering and administrative controls are such as to eliminate potential exposure in excess of the applicable MPE;
b) when, due to the unusual operating requirements, the use of eye protection is not practicable. Such operating procedures should only be undertaken with the approval of the laser safety officer.
c) maximum permissible exposure (MPE);
d) optical density of eyewear at laser output wavelength;
e) visible light transmission requirements;
f) radiant exposure or irradiance at which damage to eyewear occurs;
g) need for prescription glasses;
h) comfort and ventilation;
i) degradation or modification of absorbing media, even if temporary or transient;
j) strength of materials (resistance to shock);
k) peripheral vision requirements;
l) any relevant national regulations.

Eye protection which is designed to provide adequate protection against specific laser radiations should be used in all hazard areas where Class 3B or Class 4 lasers are in use (see clause 12). This requirement does not apply to Class 3B laser products with not more than five times the AEL of Class 2 in the wavelength range from 400 nm to 700 nm. Additional exceptions to this are:

a) when engineering and administrative controls are such as to eliminate potential exposure in excess of the applicable MPE;
b) when, due to the unusual operating requirements, the use of eye protection is not practicable. Such operating procedures should only be undertaken with the approval of the laser safety officer.

10.8.1 *Identification of eyewear*

All laser protective eyewear shall be clearly labelled with information adequate to ensure the proper choice of eyewear with particular lasers.

10.8.2 *Required optical density*

The spectral optical density D_λ of laser protective eyewear is normally highly wavelength dependent Where protective eyewear is required to cover a band of radiation, the minimum value of D_λ measured within the band shall be quoted. The value of D_λ required to give eye protection can be calculated from the formula:

$$D_\lambda = \log_{10} \frac{H_0}{MPE}$$

where H_0 is the expected unprotected eye exposure level.

10.8.3 *Protective eyewear*

Special attention has to be given to the resistance and stability against laser radiation when choosing eyewear for protection against Class 4 lasers.

10.9 *Protective clothing*

Special attention has to be given to the resistance and stability against laser radiation when choosing clothing for protection against Class 4 lasers.

10.10 *Training*

Operation of Class 1M and Class 2M laser products that failed condition 1 of table 10, Class 3R, Class 3B and Class 4 laser systems can represent a hazard not only to the user but also to other people over a considerable distance.

Because of this hazard potential, only persons who have received training to an appropriate level should be placed in control of such systems. The training, which may be given by the manufacturer or supplier of the system, the laser safety officer, or by an approved external organization, should include, but is not limited to:

a) familiarization with system operating procedures;
b) the proper use of hazard control procedures, warning signs, etc.;

c) the need for personal protection;
d) accident reporting procedures;
e) bioeffects of the laser upon the eye and the skin.

See also clause 12.

10.11 *Medical supervision*

In the absence of national regulations, the following recommendations should be taken into consideration:

a) the value of medical surveillance of laser workers is a fundamental problem as yet unresolved by the medical profession. If ophthalmic examinations are undertaken, they should be carried out by a qualified specialist and should be confined to workers using Class 3B and Class 4 lasers;
b) a medical examination by a qualified specialist should be carried out immediately after an apparent or suspected injurious ocular exposure. Such an examination should be supplemented with a full biophysical investigation of the circumstances under which the accident occurred;
c) pre, interim, and post employment ophthalmic examinations of workers using Class 3B and Class 4 lasers have value for medical legal reasons only and are not a necessary part of a safety program.

11 *Hazards incidental to laser operation*

Depending on the type of laser used, associated hazards involved in laser operations may include the following:

11.1 *Atmospheric contamination*

a) Vapourized target material and reaction products from laser cutting, drilling, and welding operations. These materials may well include asbestos, carbon monoxide, carbon dioxide, ozone, lead, mercury, other metals, and biological material.

b) Gases from the flowing gas laser systems or from the by products of laser reactions, such as bromine, chlorine, and hydrogen cyanide.

c) Gases or vapours from cryogenic coolants.

d) Gases used to assist laser-target interactions, such as oxygen.

11.2 *Collateral radiation hazards*

11.2.1 *Ultra-violet collateral radiation*

There may be a considerable hazard from the ultra-violet radiation associated with flashlamps and CW laser discharge tubes, especially when ultra-violet transmitting tubing or mirrors (such as quartz) are used.

11.2.2 *Visible and intra-red collateral radiation*

The visible and near infra-red radiation emitted from flash tubes and pump sources and target re-radiation may be of sufficient radiance to produce potential hazard.

11.3 *Electrical hazards*

Most lasers make use of high voltages (>1 kV) and pulsed lasers are especially dangerous because of the stored energy in the capacitor banks.

Unless properly shielded, circuit components such as electronic tubes working at anode voltages greater than 5 kV may emit X-rays.

11.4 *Cryogenic coolants*

Cryogenic liquids may cause burns and require special handling precautions.

11.5 *Materials processing*

Specifications for laser products used to process materials may vary according to their Intended use. If the user wishes to process materials other than those recommended by the manufacturers, he should make himself aware of the different degrees of risk and hazards associated with the processing of such materials, and take appropriate precautions to prevent, for example, the emission of toxic fume, fire, explosion or reflection of laser radiation from the workpiece.

11.6 *Other hazards*

The potential for explosions at the capacitor bank or optical pump systems exists during the operation of some high-power laser systems. There is a possibility of flying particles from the target area in the laser cutting, drilling, and welding operations. Explosive reactions of chemical laser reagents or other gases used within the laboratory are also possible.

12 *Procedures for hazard control*

12.1 *General*

Three aspects of the use of lasers need to be taken into account in the evaluation of the possible hazards and in the application of control measures:

a) the capability of the laser or laser system to injure personnel. This includes any consideration of human access to the main exit port or any subsidiary port;
b) the environment in which the laser is used;
c) the level of training of the personnel who operate the laser or who may be exposed to its radiation.

The practical means for evaluation and control of laser radiation hazards is to classify laser systems according to their relative hazard potential, and then to specify appropriate controls for each class. The use of the classification system will in most cases preclude any requirement for radiometric measurements by the user.

The classification scheme relates specifically to the accessible emission from the laser system and the potential hazard based on its physical characteristics. However, environmental and personnel factors are also relevant in determining the control measures required and a responsible person should be designated as laser safety officer, to be responsible for providing informed judgments on situations not specifically covered by this standard.

The following details relate to safe operation of laser products in:

– outdoor and construction environments where administrative controls often provide the only reasonable approach to safe operation;
– laboratory and workshop environments where engineering controls may play the greatest role;
– display and demonstration environments, where pre-planning, delineation and control of access often provide the only reasonably practicable approach to safe operation.

12.2 *Hazard evaluation for Class 3B and Class4 lasers used outdoors*

The hazard potential for Class 3B and Class 4 lasers may extend over a considerable distance. The range from the laser at which the irradiance or radiant exposure falls below the appropriate MPE is termed the nominal ocular hazard distance (NOHD). The area within which the beam irradiance or radiant exposure exceeds the appropriate MPE is called the nominal ocular hazard area (NOHA). This area is bounded by the limits of traverse, elevation and pointing accuracy of the laser system and extends either to the limit of the NOHD or to the position of any target or backstop. The exact NOHA will also depend on the nature of any material within the beam path, e.g., specular reflectors.

The NOHD is dependent on the output characteristics of the laser, the appropriate MPE, the type of optical system used, and the effect of the atmosphere on beam propagation. Formulae and examples for calculating the NOHD are given in annex A.

12.3 *Personal protection*

The need to use personal protection against the hazardous effects of laser operation should be kept to a minimum by administrative controls, engineering design and by beam enclosure.

When personnel may be exposed to potentially hazardous laser radiation (Class 3B and Class 4) adequate personal protection should be provided.

12.4 *Laser demonstrations, displays and exhibitions*

Only Class 1 or Class 2 laser products should be used for demonstration, display or entertainment in unsupervised areas. The use of other classes of lasers for such purposes should be permitted only when the laser operation is under the control of an experienced, well-trained operator and/or when spectators are prevented from exposure to levels exceeding the applicable MPE.

Each demonstration laser product used for educational purposes in schools, etc. should comply with all of the applicable requirements for a Class 1 or Class 2 laser product. A demonstration laser product shall not permit human access to laser radiation in excess of the accessible emission limits of Class 1 or Class 2 as applicable.

NOTE – Additional guidance can be found in IEC 60825-3, a technical report on the safety precautions for laser light shows and displays.

12.5 *Laboratory and workshop laser installations*

12.5.1 *Class 1M, Class 2, Class 2M and Class 3R laser products*

Precautions are only required to prevent continuous viewing of the direct beam; for Class 1M, Class 2 and Class 2M, a momentary (0,25 s) exposure to radiation in the wavelength range400 nm to 700nm as would occur in accidental viewing situations is not considered hazardous. However, the laser beam should not be intentionally aimed at people. The use of optical viewing aids (for example, binoculars) with Class 1M, Class 2M and Class 3R laser products may Increase the ocular hazard. Additional precautions for Class 1M, Class 2M and Class 3R laser products are given in 12.6.2.

12.5.2 *Class 3B laser products*

Class 3B lasers are potentially hazardous if a direct beam or specular reflection is viewed by the unprotected eye (intrabeam viewing). The following precautions should be taken to avoid direct beam viewing and to control specular reflections.

a) The laser should only be operated in a controlled area.
b) Care should be exercised to prevent unintentional specular reflections.

c) The laser beam should be terminated where possible at the end of its useful path by a material that is diffuse and of such a colour and reflectivity as to make beam positioning possible while still minimizing the reflection hazards.

NOTE - Conditions for safe viewing of diffuse reflections for Class 3B visible laser: are: minimum viewing distance of 13 cm between screen and cornea and a maximum viewing time of 10 s. Other viewing conditions require a comparison of the diffuse reflection exposure with the MPE.

d) Eye protection is required if there is any possibility of viewing either the direct or specularly reflected beam, or of viewing a diffuse reflection not complying with the conditions of item c).
e) The entrances to areas should be posted with a standard laser warning sign.

12.5.3 *Class 4 laser products*

Class 4 laser products can cause injury from either the direct beam or its specular reflections and from diffuse reflections. They also present a potential fire hazard. The following controls should be employed in addition to those of 12.5.2 to minimize these risks.

a) Beam paths should be enclosed whenever practicable. Access to the laser environment during laser operation should be limited to persons wearing proper laser protective eyewear and protective clothing.

Beam paths should avoid work area where possible, and long sections of tubes should be mounted so that thermal expansion, vibration, and other sources of movements in them do not significantly affect the alignment of beam forming components.

b) Class 4 lasers should be operated by remote control whenever practicable, thus eliminating the need far personnel to be physically present in the laser environment.

c) Good room illumination is important in areas where laser eye protection is worn. Light-coloured diffuse wall surfaces help to achieve this condition.

d) Fire, thermally Induced aberrations in optical components and the melting or vapourization of solid targets designed to contain the laser beam, are all potential hazards induced by the radiation from Class 4 lasers. A suitable beam stop should be provided, preferably in the form of an adequately cooled metal or graphite target. Very high power densities can be handled by absorbing the radiation over several reflections, each reflecting surface being inclined at such an angle to the incident radiation as to spread the laser power over a wide area.

e) Special precautions may be required to prevent unwanted reflections in the invisible spectrum from far infra-red laser radiation and the beam and target area should be surrounded by a material opaque at the laser wavelength. (Even dull metal surfaces may become highly specular at the CO2 wavelength of 10,5 μm).

Local screening should be used wherever practicable to reduce the extent of reflected radiation.

The alignment of optical components in the path of a Class 4 laser beam should be initially and periodically checked.

Ⅱ. SYSTEM OUTLINE & SPEC.

Note for this section

This section describes outline and specifications of this system.

We recommend that you use this system after reading this section and understanding this system.

1 System Outline 1-1

1-1 System Outline.....1-1

2 Specifications 2-1

2-1 Specifications of this system 2-1

3 Operating hours 3-1

3-1 Hour meter.....3-1

Regarding DIP switches at back panel of FV5-LDPSU, see V – 1 [Warning to back panel switch settings].

1 System Outline

1-1 System Outline

1. This is a semiconductor laser diode system (LD) designed as compact, low-power consumption and very quiet system.

2. LD itself is of temperature constant type so that the system can suppress fluctuation of wavelength and power.

3. Light-stable laser output can be acquired with light feedback.

4. This system can attain the function equivalent to AOTF even if connected confocal microscope does not have the function. (FV5-LD405 only)

TIP

For further details of AOTF and ROI / REX function, see manual for FV300, FV500 and FV1000.

5. Image can be acquired in various methods by integrating our FV300, FV500 and FV1000.

2 Specifications

2-1 Specifications of this system

Unit			Specifications
Semiconductor laser head			
	FV5-LD405	Output Wavelength Dimensions(mm) Mass	Max: 25mW Min: 400nm Max: 408nm Typ: 405nm 70(W)×127(D)×70(H) (With a manipulator cover) 70(W)×70(D)×70(H) (Without a manipulator cover) 500g
	FV5-LD440	Output Wavelength Dimensions(mm) Mass	Max: 5mW Min: 437nm Max: 443nm Typ: 440nm 70(W)×70(D)×70(H) 500g
Semiconductor laser power supply unit FV5-LDPSU FV5-LDPSU(Type2)		Rating Dimensions(mm) Mass	100-120/200-240V~ 0.4/0.25A 50/60Hz 210(W)×300(D)×100(H) 2,700g
Fiber cable FV5-FUR405		Kind Fiber output Length	Polarized preserved fiber cable Min: 6mW Max: 13mW (when integrated with FV5-LD405) 3m
Environment conditions			• Indoor use • Altitude up to 2000m • Temperature 10°C~35°C(FV300 and FV500) 18°C~28°C(FV1000) • Humidity 30%~80% (up to 31°C) Humidity at environment of 31°C or more will go down linearly and become 70% at 34°C. • Power voltage fluctuation: ±10% • Pollution degree 2 (IEC60664) • Installation category (Over voltage category) Ⅱ (IEC60664)
Storage environment			• Temperature -25°C~65°C • Humidity 10%~90%

This device complies with the requirements of both directive 89/336/EEC concerning electromagnetic compatibility and directive 73/23/EEC concerning low voltage. The CE marking indicates compliance with the above directives.

3 Operating hours

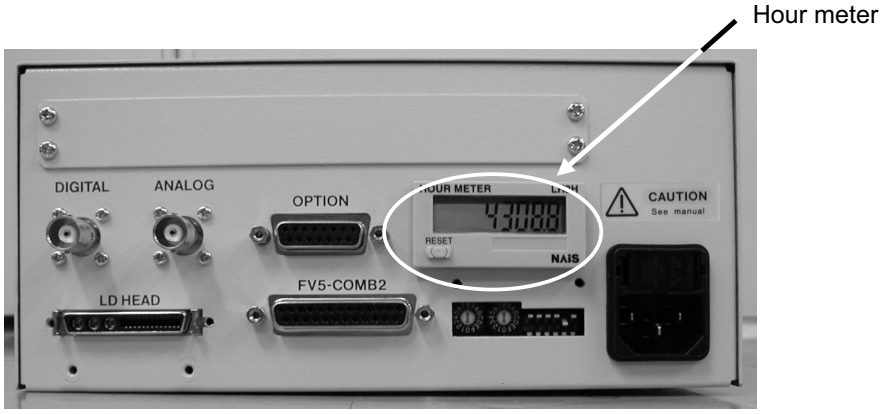
Operating hours of this system is described.

3-1 Hour meter

Hour meter is attached at back panel of FV5-LDPSU.

Hour meter indicates total time that the laser is being lighted.

NOTE **The reset switch on the Hour meter panel is not be refreshed, even if it is pushed.**



TIP

HOUR METER INDICATES THE TIME IN SEVEN DIGITS AS FOLLOWS.

HHHHMM.M

MM.M (LOWER 3 DIGITS): MINUTE IS DISPLAYED IN RANGE OF 0.00 ~ 59.9.

HHHH (UPPER 4 DIGITS): HOUR IS DISPLAYED IN RANGE OF 0 ~ 9999.

E.G.: IN CASE THAT 142123.3 IS DISPLAYED, IT INDICATES THAT THE LASER WAS LIGHTED FOR A TOTAL OF 1421 HOURS 23.3 MINUTES.

Ⅲ. PACKING DETAILS CHECK

Note for this section

This section describes packing details of this system.
We recommend that you use this system after reading this section and checking the details of packing.

1 Integration with this system 1-1

1-1 ND Combiner (FV5-COMB(2)) configuration for FV300 or FV500 with this system 1-1
1-2 AOTF Combiner (FV5-COMBA) configuration for FV300 or FV500 with this system 1-1
1-3 ND Combiner (FV5-COMB2) of FV300 / FV500 configuration with FV5-LD440 1-2
1-4 LD Interface(FV10-LDIF) configuration for LD405 laser or LD440 laser in FV1000 system 1-2
1-4-1 LD405 configuration 1-2
1-4-2 LD440 Configuration 1-2

2 Packing details of this system 2-1

3 Setup 3-1

3-1 Cable connections 3-1
3-2 FV5-FUR405 Installation and Light axis adjustment (In case of FV5-LD405) 3-2
3-3 FV5-LD405/440 Installation 3-3

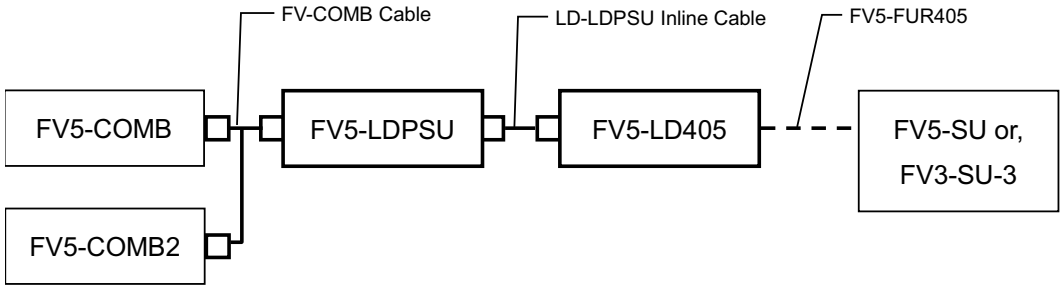
Regarding DIP switches at back panel of FV5-LDPSU, see Ⅵ – 1 [Warning to back panel switch settings].

1 Integration with this system

This system can be integrated with FV300, FV500 or FV1000 as shown below.

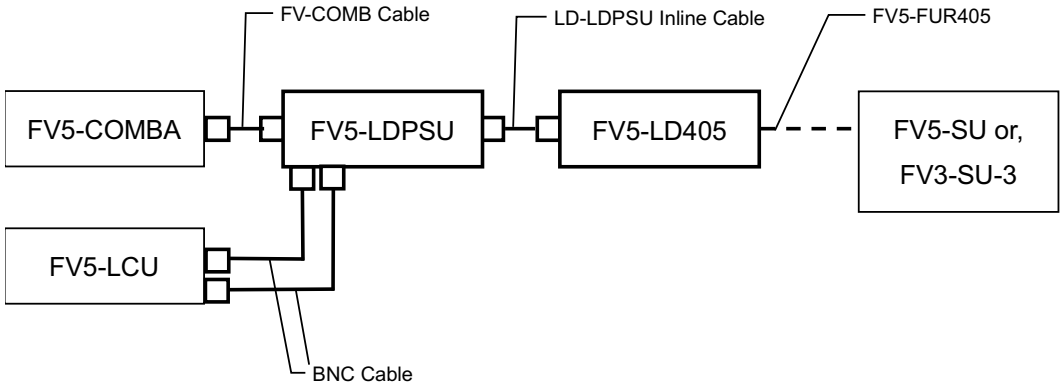
1-1 ND Combiner (FV5-COMB(2)) configuration for FV300 or FV500 with this system

This system can be integrated with FV5-COMB(2) for FV300 or FV500.



1-2 AOTF Combiner (FV5-COMBA) configuration for FV300 or FV500 with this system

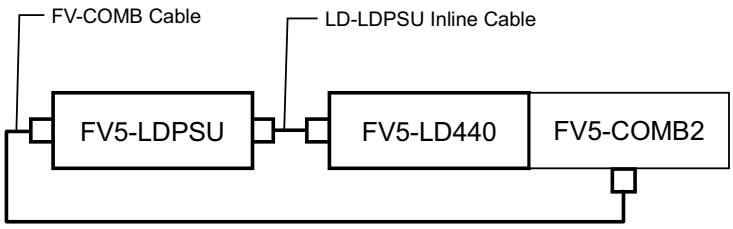
This system can be integrated with FV5-COMBA (AOTF Combiner) for FV300 or FV500.



TIP Regarding connection for FV300 or FV500, see manual for FV300 and FV500.

1-3 ND Combiner (FV5-COMB2) of FV300 / FV500 configuration with FV5-LD440

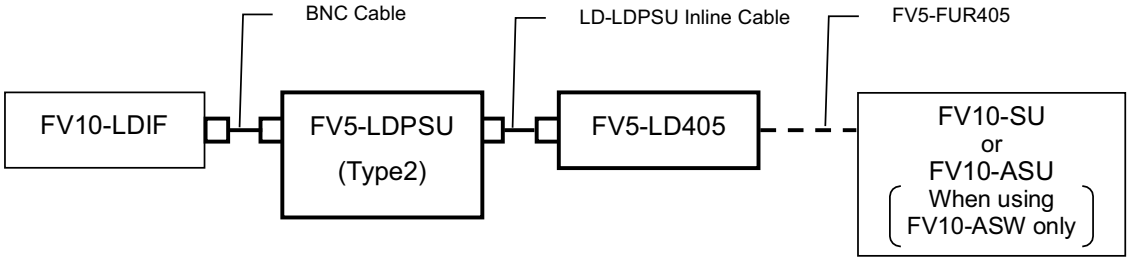
This system can be integrated with FV5-COMB2 of FV300 or FV500.



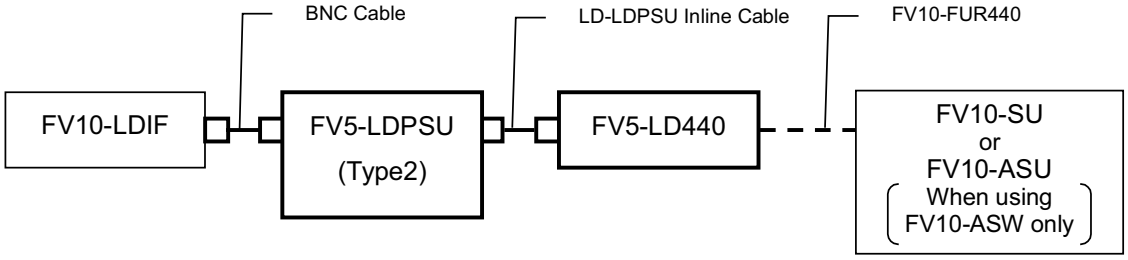
TIP For connection details of FV300 or FV500, see instruction manual of FV300 or FV500.

1-4 LD Interface(FV10-LDIF) configuration for LD405 laser or LD440 laser in FV1000 system

1-4-1 LD405 configuration



1-4-2 LD440 Configuration



TIP For connection details of FV1000, see instruction manual of FV1000.

2 Packing details of this system

Packing of this system contains the following parts.

FV5-LDPSU SET

- FV5-LDPSU (Semiconductor laser power supply unit) 1
- Cable pull-stopper 1
- FV-COMB Cable (for FV300 and FV500 that connects semiconductor laser power supply unit with laser combiner) 1
- LD-LDPSU In-line Cable (cable that connects semiconductor laser head and semiconductor laser power supply unit) 1
- BNC Cable (the cable that connects semiconductor power supply with FV5-LCU (Laser Control Unit) for FV300 / FV500 /1000 (FV5-LD405) 2

FV5-LD405 SET (When using this system on FV5-LD405 only)

- FV5-LD405 (Semiconductor laser head) 1
- Cable pull-stopper 1
- Warning label set 1

FV5-LD440 SET (When using this system on FV5-LD440 only)

- FV5-LD440 (Semiconductor laser head) 1
- Cable pull-stopper 1
- Warning label set 1

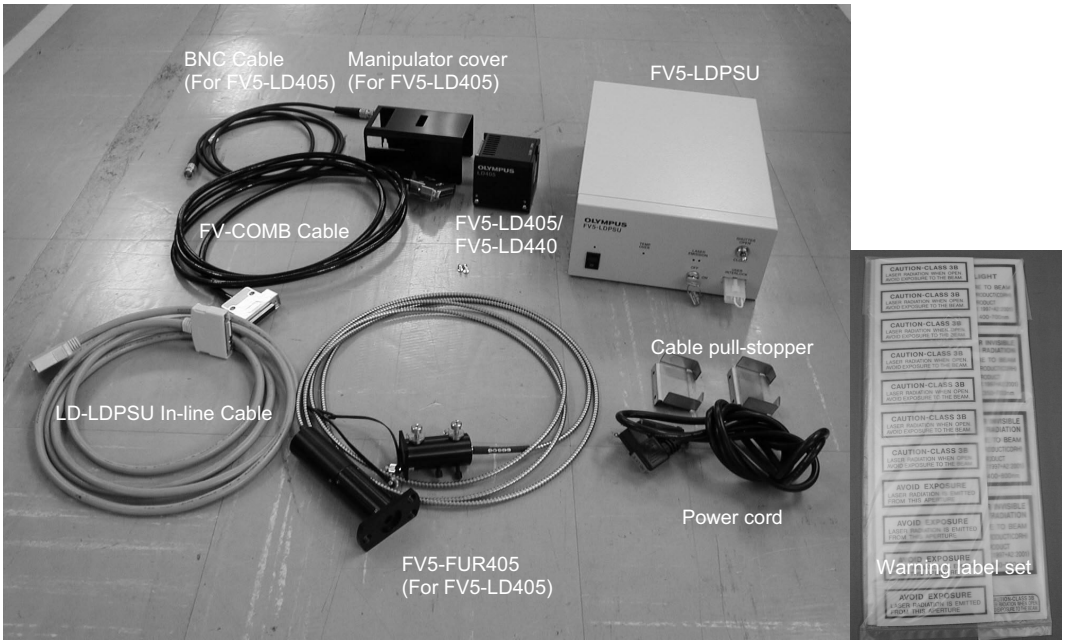
FV5-FUR405 SET (For FV5-LD405)

- FV5-FUR405 (Fiber) 1
- Manipulator cover 1
- Fixing screw set for SU of FV5-FUR405 (Washer, Spring washer, AB4x16) 3

OTHER

- Rower cord 1

Packing details of this system



3 Setup

Setup of this system is normally executed by our service personnel. This section describes setup procedures briefly.

3-1 Cable connections

1. Connect LD-LDPSU inline cable to FV5-LD405 and fasten cable pull-stopper firmly.

NOTE

Fasten screws of cable pull-stopper tightly for sure. In case that LD-LDPSU inline cable comes off from FV5-LD405, FV5-LD405 becomes shaky and it would lead to breakage. In addition, if cable comes off during running time, it would cause a failure.

2. Connect LD-LDPSU inline cable to LD-HEAD connector of FV5-LDPSU and fasten cable pull-stopper firmly.

NOTE

Fasten screws of cable pull-stopper tightly for sure. In case that LD-LDPSU inline cable comes off from FV5-LDPSU, FV5-LD405 becomes shaky and it would lead to breakage. In addition, if cable comes off during running time, it would cause a failure.

3. Insert power cord into power cord connector of FV5-LDPSU.

TIP

When you use FV300 or FV500, connect FV-COMB cable from FV5-COMB(2) or FV5-COMBA with FV5-LDPSU. Operation of FLUOVIEW software from FV300 or FV500 is possible. For detail, refer to FV300 or FV500 manual.

TIP

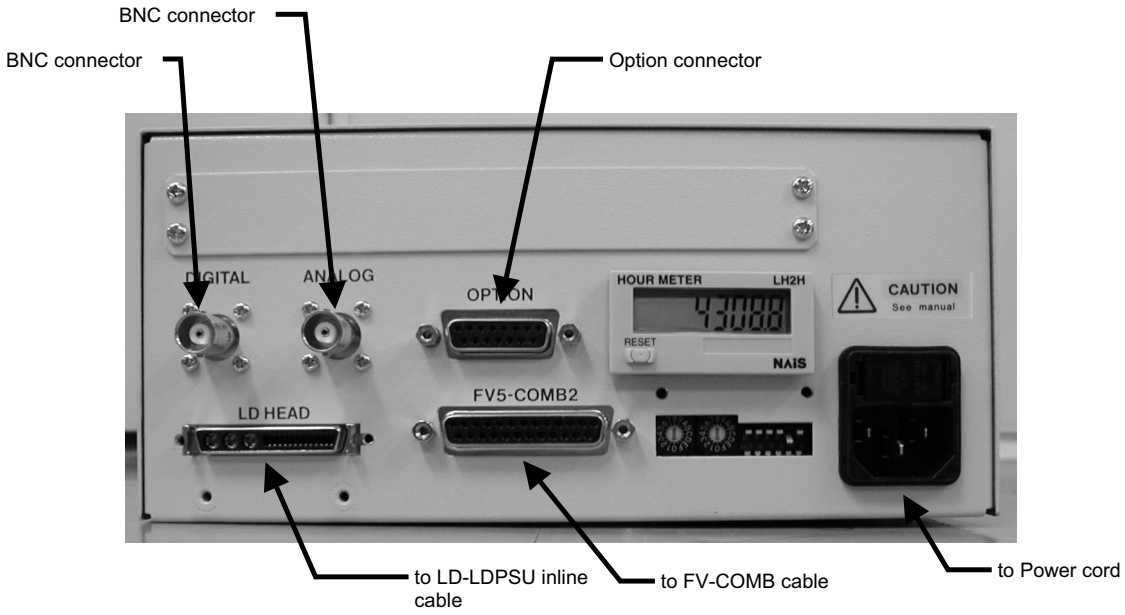
When you use FV300 or FV500 and you set AOTF combiner (FV5-COMBA), you can use REX function at the following connections and settings.

1. Connect BLANKING connector of FV5-LCU and ANALOG connector of FV5-LDPSU with BNC cable.
2. Connect UV connector of FV5-LCU and DIGITAL connector of FV5-LDPSU with BNC cable.
3. Set UV rotary switch of FV5-LCU to "1".

For details of REX function see instruction manual of FV300 or FV500.

TIP

When you use FV1000 and you connect ANALOG connector of LD Interface (FV5-LDIF) with ANALOG connector of FV5-LDPSU(Type2), using BNC cable. ROI / REX function can be used. For details of ROI / REX function, refer to FV1000 manual.



3-2 FV5-FUR405 Installation and Light axis adjustment (In case of FV5-LD405)

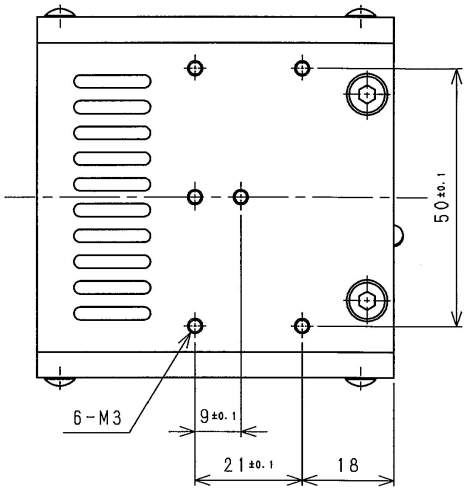
1. Install FV5-FUR405 to FV5-LD405 and adjust light path, using manipulator.

2. Attach manipulator cover to manipulator.

3. Attach fiber tip of FV5-FUR405 to the place where laser should emit.

3-3 FV5-LD405/440 Installation

- Threaded holes to fix base to the bottom of FV5-LD405/440 are provided. Location of holes is shown in a figure. (unit = mm). It is possible to fix the base, using 6 screws M3 of 12mm long or less.



Bottom

(Figure represents FV5-LD405. It is the same as FV5-LD440.)

- Place FV5-LD405/440 on horizontal surface of base with its bottom facing down. Do not place it upside down or sideway.

Ⅳ.OPERATION INSTRUCTIONS

Note for this section

This section describes operation of this system.
We request that you use this system after reading this section and understand the system.

1 Powering up and shutdown 1-1

1-1 Powering up 1-1
1-2 Shutdown 1-2

2 Laser emission 2-1

2-1 When laser emits 2-1
2-2 When you wish to stop laser emission 2-2

3 Laser intensity change 3-1

3-1 Laser intensity change for ND combiner (using FV300 or FV500) 3-1
3-2 Laser emission area and Laser intensity change for AOTF combiner (using FV300 or FV500) 3-2
3-3 The way of changing the emission area(ROI / REX) and intensity of Laser with LD Interface (FV10-LDIF) configuration (FV1000 system) 3-3

4 Description of LED indicators 4-1

4-1 LASER EMISSION LED 4-1
4-2 TEMP. OVER LED 4-1

Regarding DIP switches at back panel of FV5-LDPSU, see Ⅵ – 1 [Warning to back panel switch settings].

1 Powering up and shutdown

1-1 Powering up

1. Verify that remote interlock (1) is set properly.

TIP

See Ⅰ. 1-4 page for instruction of remote interlock.

2. Connect power cord to power consent.

3. Turn power switch (2) to | - (ON) position.

4. Turn key switch (3) right to ON position.

5. Turn shutter switch (4) OPEN.

TIP

When you use FV300, FV500 or FV1000, boot up FV300, FV500 or FV1000 software.

NOTE

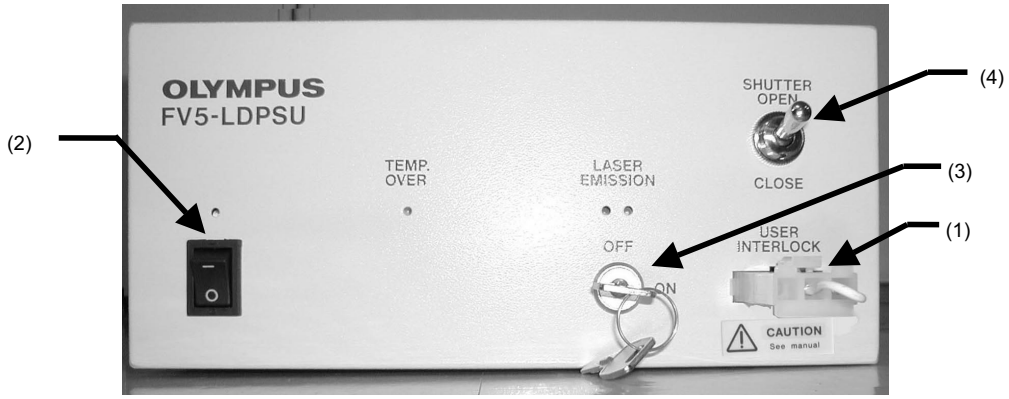
When you use the FV1000, at first, you turn on the FV10-PSU and the UCB. Next you turn on the FV5-LDPSU. Last, you run the FV10-ASW / FV10-SW software.

NOTE

In case that FV300/500 is used, power of FV5-LDPSU must be turned ON and then, FV300 / FV500 software must be booted.

NOTE

When you use FV5-LD405 and FV5-FUR405, manipulator adjustment of fiber is done by our service personnel. Do not touch the manipulator. If you accidentally touch the manipulator, light path of fiber may be displaced and laser power from tip of fiber may get weak.



Front panel of FV5-LDPSU

1-2 Shutdown

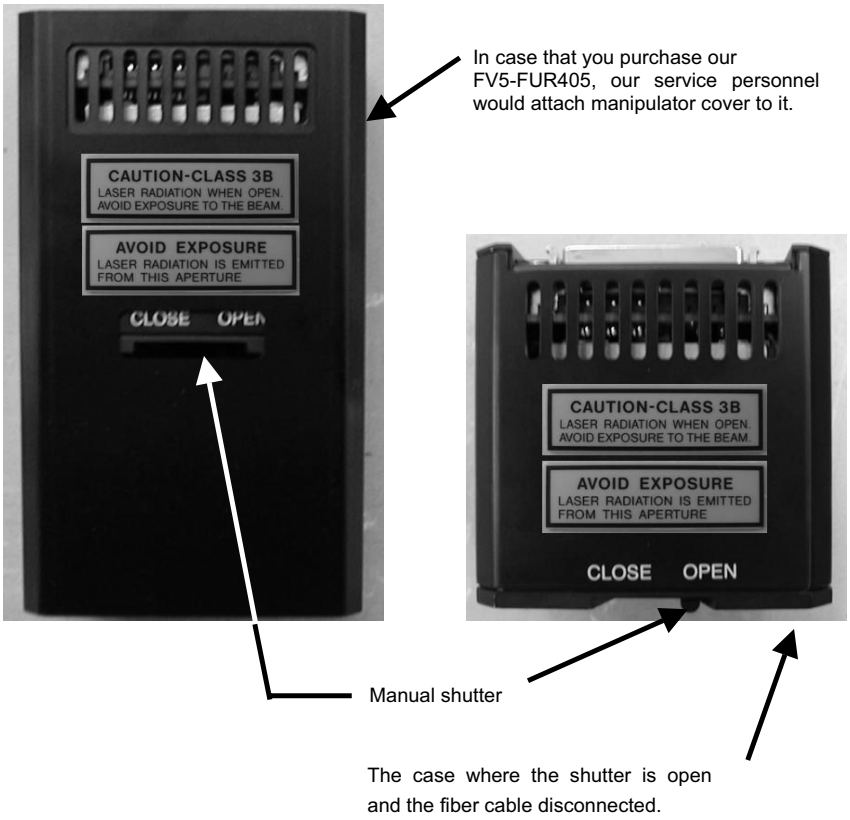
TIP When FV300, FV500 or FV1000 is used, close FV300, FV500 or FV1000 software.

1. Turn shutter switch (4) to CLOSE.
2. Turn key switch (3) left to OFF position.
3. Turn power switch (2) to O-(OFF) position.
4. In case that laser is not used for a long period of time, pull out power cord from power consent.
5. Turn off the FV10-PSU and the UCB. (FV1000)

2 Laser emission

2-1 When laser emits

TIP When you wish to emit laser, turn manual shutter to OPEN.


In case that you purchase our FV5-FUR405, our service personnel would attach manipulator cover to it.
CAUTION-CLASS 3B
LASER RADIATION WHEN OPEN.
AVOID EXPOSURE TO THE BEAM.
AVOID EXPOSURE
LASER RADIATION IS EMITTED FROM THIS APERTURE
CLOSE OPEN
Manual shutter
The case where the shutter is open and the fiber cable disconnected.

When manual shutter is turned OPEN, laser would emit in continuous wave mode, provided that the following conditions are satisfied.

- Interlock is short-circuited.
- Power switch is turned to | -(ON) position.
- Key switch is ON.
- Shutter switch is OPEN.

- FV300 or FV500 is not yet connected and DIP switch No.5 on back panel of FV5-LDPSU is turned ON. In case that you use FV300 or FV500 and DIP switch No.5 located at back panel of FV5-LDPSU is turned to OFF position, the operation of SCAN should be done on FV300 / FV500 software. In FV1000 system, if you want to acquire the image to control LD laser, you must set the DIP switch No.5 to be ON. See instruction manual of FV300, FV500 or FV1000 regarding software operation.

NOTE **Regarding DIP switch setting on back panel of FV5-LDPSU, refer to Ⅵ – 1 [Back panel switch settings].**

2-2 When you wish to stop laser emission

Even if shutter is OPEN, laser emission would stop provided that any of the following conditions is satisfied.

- FV300, FV500 or FV1000 is not yet connected and DIP switch No.5 on back panel of FV5-LDPSU is turned OFF.
- Remote interlock is turned OPEN.
- Power switch is turned O-(OFF).
- Key switch is turned OFF.
- Shutter switch is turned to CLOSE.

TIP In case that FV300 or FV500 is used, shutter would close if FV300 / FV500 software scanning operation is stopped. In FV1000 system, Laser emission stops when FV10-ASW / FV10-SW software scanning operation is stopped. See instruction manual of FV300, FV500 or FV1000 regarding software operation.

TIP Laser emission would also stop when manual shutter is turned to CLOSE.

3 Laser intensity change

Laser intensity can be changed according to the following methods.

3-1 Laser intensity change for ND combiner (using FV300 or FV500)

When FV300 or FV500 is used and laser combiner is arranged with ND (FV5-COMB / FV5-COMB2), laser intensity can be changed from FV300 or FV500. Laser intensity can be changed from 1% to 100% if the maximum value is set to 100%. For further details, see instruction manual for FV300 or FV500.

1. Connect FV5-COMB(2) with FV5-LDPSU.

2. Set laser intensity (%) with use of scale – [Laser Intensity] group box of FV300 or FV500 software.

3. Start scanning. Laser intensity can be changed by changing the setting.

Set back panel switch of FV5-LDPSU properly. Regarding DIP switch setting, refer to Ⅵ – 1 [Back panel switch settings].

When you use this system as standalone, refer to Chapter 2 [Laser emission].

3-2 Laser emission area and Laser intensity change for AOTF combiner (using FV300 or FV500)

When FV300 or FV500 is used and laser combiner is arranged with AOTF (FV5-COMBA), laser intensity and laser emission area (REX) can be changed. For further details, see instruction manual for FV300 or FV500. Laser intensity can be changed from 1% to 100% if the maximum value is set to 100%.

1. Verify that FV5-COMBA is connected with FV5-LCU.

2. Connect FV5-LCU with FV5-LDPSU.

3. Set REX from FV300 or FV500 software.

4. After REX setting, start scanning so that laser emission area can be changed.

TIP As in the case of FV5-COMB(2), laser intensity can also be changed with scale setting of [Laser Intensity] group box. In case that FV5-COMBA is used, the laser intensity can be changed from 1% to 100% if the maximum value is set to 100%.

NOTE **Set back panel switch of FV5-LDPSU properly. Regarding DIP switch setting, refer to VI – 1 [Back panel switch settings].**

TIP When you use this system as standalone, refer to Chapter 2 [Laser emission].

3-3 The way of changing the emission area(ROI / REX) and intensity of Laser with LD Interface (FV10-LDIF) configuration (FV1000 system)

When FV1000 is used and FV10-LDIF, laser intensity and laser emission area (ROI / REX) can be changed. For further details, see instruction manual for FV1000. Laser intensity can be changed from 1% to 100% if the maximum value is set to 100%.

1. Connect FV10-LDIF with FV5-LDPSU(Type2).

2. Set ROI / REX from FV10-ASW / FV10-SW software.

3. After ROI / REX setting, start scanning so that laser emission area can be changed.

TIP Intensity can also be changed with scale setting of [Laser] group box (when you use FV10-ASW) or [Laser Intensity] group box (when you use FV10-SW). In case that FV10-LDIF is used, the laser intensity can be changed from 1% to 100% if the maximum value is set to 100%.

NOTE **Do not change back panel switch settings done at our setup time on FV5-LDPSU.**
For further details, see [Back panel switch settings].

TIP When you use this system as standalone, refer to Chapter 2 [Laser emission].

4 Description of LED indicators

LED indicators that light during scanning are explained.

4-1 LASER EMISSION LED

Two LASER EMISSION LED's are attached to the front side of FV5-LDPSU. In case that either of two is lighting in red, it indicates that laser is being emitted from FV5-LD405 provided that manual shutter was turned to OPEN.

In case that LASER EMISSION LED is not lighting, it indicates that laser is not emitted. When you wish to emit laser, see 2-1 [When laser emits] and satisfy the conditions required.

TIP

There is an exception that laser may not be emitted although the LED is lighting, in case that the shutter switch on the front panel of FV5-LDPSU is at CLOSE position (See 2-1 [When laser emits]).

4-2 TEMP. OVER LED

This LED is an alarm to indicate abnormal temperature on FV5-LD405 or FV5-LD440.

When it is lighting or blinking in red, turn power to OFF position once and then, power up again. When the error is not recovered after power up again, contact our local sales office.

V. TROUBLESHOOTING

Note for this section

This section describes countermeasures for troubles.
Before you contact our local sales office, please read this section and try the countermeasures. In case that the trouble occurs persistently, then, contact our local sales office.

1 Countermeasure when trouble occurs 1-1

1. Laser does not emit.....1-1
2. Laser power is weak.....1-1

Regarding DIP switches at back panel of FV5-LDPSU, see Ⅵ – 1 [Warning to back panel switch settings].

1 Countermeasure when trouble occurs

It may not be a failure but, depending upon how it is used, the system may not perform as expected. When trouble occurs, do countermeasure as shown in the following table. In case that the same trouble occurs even after the countermeasure, contact our local sales office.

Phenomenon	Cause	Countermeasure	Where to refer
1. Laser does not emit	Power switch is not turned ON.	Turn it ON.	Ⅳ 1-1 Section
	Key switch is not turned ON.	Turn it ON.	Ⅳ 1-1 Section
	Shutter is turned CLOSE.	Turn it to OPEN. Even if you use FV300, FV500 or FV1000 and shutter switch is turned to CLOSE, laser does not emit for safety purpose.	Ⅳ 1-1 Section
	Remote Interlock is not correctly connected. Alternatively, short pin is removed.	Contact our local sales office.	Ⅰ 1 Section
	LED of TEMP.OVER is lighting.	Laser temperature is high. Switch off POWER. Powering up again and, if laser does not emit, switch off the POWER and contact our local sales office.	Ⅳ 4-2 Section
	DIP switch setting is not correct.	Set correctly.	Ⅵ 1-1 Section
2. Laser power is weak.	Manipulator adjustment is displaced.	Contact our local sales office.	———

VI. BACK PANEL SWITCH SETTINGS

Note for this section

This section describes particularly important issue – back panel switch settings. Read this section before you use the system.

1 Warning to back panel switch settings 1-1

1-1 Dip Switch Settings 1-1
1-2 Rotary Switch Settings..... 1-3

1 Warning to back panel switch settings

1-1 Dip Switch Settings

Leave DIP switch 1, 2 and 3 set to OFF position and use this system as is.
Regarding DIP switch 4, 5 and 6, see the following description carefully and set them correctly. In case that these are not set correctly, laser may accidentally emit and cause hazard to human body.
Depending upon how DIP switches on back panel of FV5-LDPSU are set, an electric shutter can open or close with shutter switch only. In addition, laser output becomes 100% depending upon how DIP switches are set.
When ON or OFF setting of DIP switch is not known, contact our local sales office before you use the system.

DIP switch settings

1	2	3	4 (Laser output control)	5 (Electric shutter control)	6 (REX of FV5-LCU)
OFF	**OFF**	**OFF**	When laser is controlled with FV300, FV500 or FV1000, turn this switch to **OFF** position.	When shutter is controlled with FV300 orFV500, turn this switch to **OFF** position. In FV1000, this switch should be ON not OFF.	When FV5-LDPSU and FV5-LCU are not connected with use of BNC cable, turn this switch to **OFF** position. In FV1000, this switch should be OFF not ON.
			In case that laser is used with max. power, turn this switch to **ON** position.	When shutter is controlled with this system only, turn this switch to **ON** position.	When FV5-LDPSU and FV5-LCU are connected with use of BNC cable, turn this switch to **ON** position.

- When laser is controlled with FV300, FV500 or FV1000, set DIP switch **4** to OFF position. When you use this system without connecting with FV300, FV500 or FV1000, set this switch to ON position. Laser output would become max power all the time.

In case that this system is connected with FV300, FV500 or FV1000, set DIP switch 4 to OFF position for sure. If you use this system with DIP switch set to ON position, it is very dangerous as control from FV300 /FV500 /FV1000 software is not possible.

- DIP switch **5** should be set to **OFF** position in case that electric shutter is controlled in remote mode with FV300 or FV500. In addition, laser does not emit if the shutter switch were turned to CLOSE. When you wish to control the electric shutter in remote mode, turn the shutter switch to OPEN all the time. When you use this system without connecting with FV300 or FV500, set this switch to **ON** position. OPEN/CLOSE operation of shutter switch makes electric shutter open or close.

In case that this system is connected with FV300 or FV500, set DIP switch 5 to OFF position for sure. If you use this system with DIP switch set to ON position, it is very dangerous as control from FV300 / FV500 software is not possible.

In case that this system is connected with FV1000, set DIP switch 5 to ON position for sure. If you use this system with DIP switch set to OFF position, it is very dangerous as control from FV10-ASW /FV10-SW software is not possible.

- DIP switch **6** should be set to **OFF** position in case that FV5-LCU of FV300 or FV500 is not connected with FV5-LDPSU with use of BNC cable. When connecting, set it to **ON** position. If it were set to ON position, REX function of FV5-LCU can be used. Regarding REX function, refer to IV section 3-2. For further details, see manual of FV300 or FV500.

Default settings of all DIP switches are set to OFF when our system is shipped. However, in case that you use FV300, FV500 or FV1000, our service personnel would make the DIP switch settings properly.

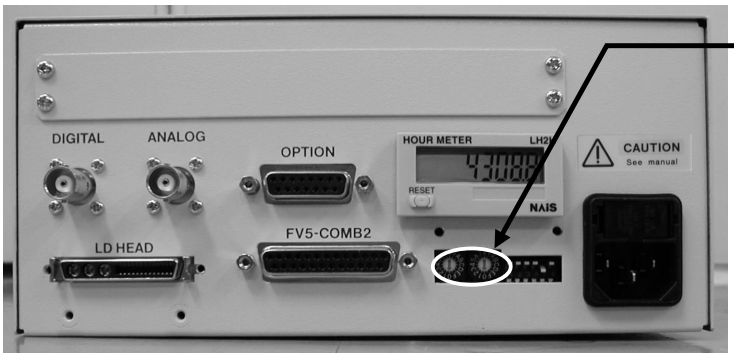
In case that this system is connected with FV1000, set DIP switch 6 to OFF position for sure. If you use this system with DIP switch set to ON position, it is very dangerous as control from FV10-ASW / FV10-SW software is not possible.

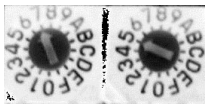
1-2 Rotary Switch Settings

Change right side rotary switch only. Do not touch left side rotary switch. If you change left rotary switch, you may not be able to get optimum performance of this system.

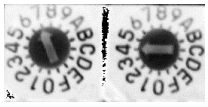
When you use FV5-LD405, align arrow mark of right side rotary switch with 5.

When you use FV5-LD440, align arrow mark of right side rotary switch with 4.





(In case of FV5-LD405)



(In case of FV5-LD440)

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